# SCIENCE

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## THE WORK OF THE U. S. GEOLOGICAL SURVEY.[1]

BY J. W. POWELL, DIRECTOR.

### Organization.

UNDER statutory provisions, it is the function of the Geological Survey to classify the public lands and examine the geologic structure and the mineral resources and products of the national domain, and to prepare a geologic map of the United States.

When the bureau was instituted in 1879, it was organized into a number of geologic divisions by the first director, Mr. Clarence King. Work was at once commenced in western States and Territories in several localities selected by reason of great mineral wealth or special scientific interest.

It was found at the outset that there were no adequate maps of the regions selected for survey; and it soon became evident that the geologic work could not be carried on without maps showing the relief of the land as well as the hydrography and culture. Accordingly, topographic surveys were instituted in each of the regions selected for examination. At first these surveys were planned to meet immediate needs, and the methods of mapping were not systemized or unified; the scales were diverse and the methods various, the areas were selected by geologic needs and were not fitted to a general scheme for the geologic map of the country, and the resulting maps were discordant in their conventions. At this stage the topographic surveys were executed under the direction of the chiefs of the geologic divisions. After two or three years of trial this form of organization was found unsatisfactory, and the topographic surveys were separated from the geologic work and assigned to a geographic division, which has ever since been maintained.

When the bureau was created, the science of geology was less specialized than to-day, and the geologists assigned to the different divisions were individually charged with the duties of identifying fossils, making analyses and assays, recording mineral statistics, and other collateral work, in addition to their areal and structural surveys; but, with the expansion of the several divisions, the different lines of work were gradually differentiated in each, so that each chief geologist employed assistants charged with special work; and still later it was found more economical to separate the collateral work for the entire survey, and to assign it to special divisions. In this way a division of chemistry and physics, a division of mining statistics and technology, and several divisions of paleontology were created and have since been maintained.

In the beginning the geologists commonly made their own drawings and constructed their own geologic maps; but with the extension of the work it was found better to assign all such mechanical work to skilled draftsmen; and still later it was found more economical to concentrate the work of this character in a division of illustrations.

Under the comprehensive plan for the construction of a geologic map of the United States, the topographic surveys were planned to yield atlas-sheets of uniform character, so related as together to make up a great map of the national domain. At first these atlas-sheets were engraved under contract through the Public Printer; but it was subsequently ascertained by experiment that the engraving could be executed at much less cost in the office of the Geological Survey, and an engraving division was instituted and is still kept up.

Thus the principal branches of work in the bureau are (1) the geologic survey proper, including the examination of the public lands and the study of mineral deposits as well as the preparation of the geologic map; (2) a topographic survey, designed as a basis for the geologic map of the United States; (3) paleontologic researches, designed primarily to aid geologists in the identification and classification of rock formations and mineral deposits, and incidentally to increase knowledge of past life upon the earth; (4) the collection and publication of mineral statistics; (5) the chemical and physical examination of ores, rocks, and other mineral substances; (6) the preparation of special charts and other illustrations for reports; and (7) the engraving of topographic and geologic maps. Clerical, editorial, and other lines of work are also carried on.

### Current Work.

Three principal lines of work are carried on, to which the other lines are collateral. Foremost among these is the geologic survey proper, which is made with a view to the preparation of the geologic map of the United States; but this work can be carried forward only in those areas in which the second principal line of work, i.e., the topographic survey, is completed. The third principal line is the collection and publication of information concerning the mineral resources and mining products of the country.

In describing the work of a scientific institution it is necessary to distinguish two stages in the development of scientific work, viz., the preliminary, or experimental, or preparatory stage, and the final or effective stage. During the first stage methods are devised, experiments are conducted, scientific apparatus is invented and subjected to trial, and the plan for the work is formulated; during the second stage the methods and apparatus are practically employed and the plans are carried out. Thus the first stage is that of research, more or less recondite according to the character of the work, the second stage is that of applied science; and since it is the highest function of systemized knowledge to promote human welfare, the first stage represents the seed-time, the second the harvest-time of science.

Now, in classing the work of scientific institutions by these stages, it is to be observed that the stages are unequal in all cases and dissimilar when different cases are compared: Thus, topographic surveying may be considered as an art and the methods and apparatus already known may be employed without research into principles or the development of new methods, or the art may be considered incomplete and new principles and methods may be developed from research and experiment; while geodesy always involves research concerning principles, which, in turn, affects methods. So, too, geologic surveys might be taken to represent applied science, and geologic tryos might be sent over the land to plat dips, strikes and outcrops, and to construct simple and primitive geologic maps adapted to the needs of the preceding generation; but it is the honor of geology that geologic surveys have commonly begun their work by researches relating to their special fields, and have thus advanced the science and subserved the needs of their own contemporaries and the coming generations. Again, simple land surveys represent art or applied science alone, while the natural history surveys sometimes conducted by States represent nearly pure research. In brief, it may be said that the proportion of research to effective work increases with the complexity of the branch of knowledge to which it pertains. So in the three principal lines of work in the Geological Survey, the collection of information concerning mineral resources and mining products is a statistical work involving no research and little experiment; the topographic survey might have been conducted by old methods and apparatus without research and experiment, but since these were expensive and dilatory, considerable preparatory work became desirable; while the geologic survey required a vast amount of research and experiment for the purpose of developing a sat-

[1] Read before the Geological Society of America at Ottowa, Dec. 30, 1892.

isfactory classification of rocks and a satisfactory system of mapping. These conditions, in connection with the conditions growing out of the changes in the organic law of the bureau, have determined the character and progress of work in the Geological Survey.

The work of collecting mineral resources has been steadily carried forward, and it has been found thereby that the mineral production of the country has more than doubled within the thirteen years since the institution of the Survey, and that many new resources have been discovered and utilized. The statistics are collected with care by means of an elaborate system of correspondence and collaboration, and are published in a series of annual volumes. The annual mining product of the country has now reached the value of six hundred and fifty million dollars. The products form the basis for many of our industries and a large proportion of our commodities, and give employment to a great part of our population. Thus a principal source of our national prosperity is made public and rendered available for further development through this part of the work of the Geological Survey.

At first the art of topographic surveying was imperfect and the work was slow and expensive. Accordingly, experiments were conducted in different types of country, with different kinds of apparatus, and with different men and methods; and, after determining the best methods and apparatus for each part of the country, a corps of topographers was trained. This experimental stage of the work lasted four or five years, though the experiments were so conducted as to yield useful results which are incorporated in the atlas-sheets representing the general topographic survey. Some of the earlier sheets were, however, found defective, and in these cases the experimental surveys were repeated and the sheets revised. The topographic surveys have how been completed over an area of about six hundred thousand square miles, or about one-fifth of the national domain, exclusive of Alaska. The total cost, including experimental work and an extensive plant, has ranged from one dollar to fourteen dollars per square mile, averaging about four dollars. Thus it is believed that the surveys of the bureau have been more expeditious and less expensive than any other topographic surveys of equal accuracy thus far made in any country. The work is not geodetic, nor is it cadastral; yet, while it is primarily designed only as a basis for the geologic surveys and thus for the geologic map contemplated in the statute, the atlas sheets have been found useful for many other purposes. They are in constant demand by engineers, road commissioners, miners, and prospectors, and are widely accepted as the most useful bases for mining and commercial maps and school and general atlases.

When the geologic studies were commenced much of the national domain had never been examined by geologists, and thus the rock formations and mineral deposits of the country were not classified; moreover, there was no comprehensive plan for geologic mapping. Accordingly, in geology as in topography, the initial stage of the work was preparatory and was designed to develop, first, a system of classification of rocks, and, second, a system of mapping them. But, while the work was experimental, it was conducted in accordance with the best systems of classification and mapping already in vogue in this and other countries, and was thus made to yield useful results which are published in preliminary maps and reports. These preliminary results of the work are incorporated in thirteen royal octavo annual reports (of which the last three are about to leave the press), twenty quarto monographs, and one hundred octavo bulletins, in addition to seven octavo volumes of the reports of mineral resources.

By reason of the immaturity of the science, and by reason of the vast extent and complexity of the rocks of the country, the preliminary stage in this work was longer than in topography, lasting indeed ten or twelve years. Within the last two years the classification of rocks, mineral deposits, and superficial formations has been so far elaborated as to warrant use as a basis for the geologic map of the United States; and, at the same time, a system of mapping has been developed. Under this system provision is made for representing the sedimentary, igneous, and ancient crystalline formations, as well as the mineral deposits associated with each, by distinct conventions; and provision is made also for mapping the superficial formations on separate sheets in those regions in which they are well developed and of economic or scientific importance. This system of mapping has been under actual trial for two years, and is now practically applied. Over a dozen sheets have been engraved in the office of the Survey within the past year, and several others have been published or are in press, appended to reports on special regions or topics; and a still larger number are completed in manuscript. One hundred atlas-sheets representing rock formations and mineral deposits, each constituting a section of the final map, are engraved or ready for engraving; and these sheets cover an area of about 120,000 square miles, or four per cent of the national domain, exclusive of Alaska. Moreover, sixty atlas-sheets showing superficial formations have been completed in regions in which the underlying rocks are generally inaccessible and of little economic value, and these sheets cover an additional area of about 60,000 square miles. Thus the aggregate area now mapped geologically reaches 180,000 square miles, or six per cent of the national domain.

In addition to the areal surveys, important results have flowed from the researches conducted by the Geological Survey. These results are not easily stated, partly because science is not quantitative and cannot be weighed and measured in any standard units, partly because science is common property and some portion of each great result is to be credited to scientific investigators not connected with the bureau. Nevertheless, a number of valuable additions to the science of geology have been made during the past decade, largely through the labors of the able corps of experts, to whose skill, zeal, and industry the bureau owes much of its success. Among these may be mentioned, the recognition and founding of a great rock system, the Algonkian; the discrimination of glacial deposits throughout northern United States and the interpretation of the complex and wonderfully interesting history of which they are records; the discovery of the rate of seismic transmission and of other laws of earthquakes; a classification of the igneous rocks and a tentative grouping of the ancient crystallines; the development of a new division of geologic science — Geomorphy, or the New Geology — in which the past history of the earth is read from topographic forms, as formerly from formations and their fossils; and a general physical classification of the rocks of a considerable portion of the country.

The cost of the areal geologic work has ranged from less than a dollar per square mile in provinces of simple structure to fifty or sixty dollars per square mile in certain mining regions of exceptionally complex structure. The average cost, making reasonable allowance for reconnaissance, and reckoned on the basis of aggregate appropriations, is eight or nine dollars per square mile. It is to be noted that this figure includes all collateral work in paleontology, chemistry and physics, mineral resources, engraving, and miscellaneous work of all kinds, as well as the acquisition of a large library, the publication of one hundred and forty reports, the training of experts, and the purchase and maintenance of an extensive plant, together with a general reconnaissance of the country. The actual cost of the geologic surveys in two representative provinces, including field and office work as well as supervision and revision, ranges from two to three dollars per square mile. Accordingly, although the geologic work is barely past the experimental stage, the cost compares favorably with that of similar work executed in foreign countries and in our own States.

### Future Work.

It is believed that the organization of the work of collecting and publishing mineral statistics is now so complete and the corps of correspondents and other collaborators so expert and zealous that this branch of the work may be carried forward more expeditiously and economically than ever before. It is the design not only to continue but gradually to expand this branch of the work, in order that it may keep pace with the increasing development of mining production, the discovery of new mineral resources, and the invention of new applications for resources already known.

While some mistakes have been made, it is believed that the topographic methods and the apparatus employed are now thoroughly effective; and that for this reason, and for the further reason that a corps of expert topographers has grown up, this branch of the work can also be carried forward more expeditiously and economically than ever before. At first most of the work was executed on a scale of four miles to the inch, another part on the scale of two miles to the inch, and only a small part on larger scales; but the improvement in methods, apparatus, and skill has been such that the surveys can be made on a scale of a mile to the inch at slightly greater cost than the original surveys on a quarter of that scale; and, accordingly, all the surveys of the bureau are now made on the two-mile scale and the one-mile scale, and the four-mile scale has been abandoned. It is proposed to continue the work on these scales, and to give such attention to minor topographic details as to yield a good topographic map of the entire country, which, while neither geodetic nor cadastral, will serve as a satisfactory basis for geologic surveys and for a wide variety of industrial purposes.

In geologic surveying, and thus in the preparation of the geologic map of the United States, the work is rapidly passing from the preliminary stage of research to the effective stage of applied science; and it is believed that the methods developed are so far satisfactory as to warrant a definite working plan for the future. This plan includes a system of rock classification and a system of map conventions based thereon by which widely applicable and useful distinctions may be made. It includes also a system of arranging the atlas-sheets constituting sections of the geologic map of the United States provided for by the statute, and the accompanying descriptive text in atlas folios designed for convenient distribution and use. Each atlas folio is inclosed in a cover bearing a suitable title and a key-map locating the atlas-sheet, and each contains a copy of the topographic sheet without geologic colors; a second copy colored by formations; a third copy colored by groups with structure sections introduced; a fourth copy colored by formations of economic value and showing also the locations of mines and industrial establishments depending on mineral resources; in the glaciated regions a fifth copy showing superficial formations and their resources; and sometimes additional sheets giving columnar sections and other illustrations of the region. The accompanying text includes an elementary explanation of the atlas, a general sketch of the geologic province, and a special description of the area covered by the sheet. Furthermore, the plan contemplates the extension of the geologic surveys from the regions of complex structure, in which the classifications were developed, into regions of simpler structure, in which more rapid progress may be anticipated. Moreover, since a corps of experts has now been trained in the methods and the classification developed in the bureau, and since these experts are now ready to extend operations into the rich mining regions and other important fields in which premature work would have been unwise, it is planned to strengthen this technical work and thus to enhance the economic value of the geologic map without detracting from its scientific character.

The purpose of our statesmen in instituting the Geological Survey was to enable those engaged in mining and related industries to exploit our mineral resources safely and economically. It has always been recognized that mineral resources depend on rock structure, and that the structure and relations of rocks cannot be made intelligible to practical men without classification; moreover, it was understood that the structure and relations of rocks cannot be described, and in some cases cannot even be ascertained, without maps. It was for these reasons that statutory provision was made for the construction of a geologic map of the United States in connection with the examination of the mineral resources and mining products; it was for the same reasons that the topographic survey was undertaken as a basis for the final geologic map. The work of the topographic branch of the bureau has passed the experimental stage and entered upon the effective stage, while the work of the geologic branch is now passing from the stage of elaborate and often recondite research to the effective stage; and it is designed to carry forward the work of both branches with energy and to proceed with the preparation of the geologic map on a basis at once thoroughly scientific and economically useful. In fact, during the past two or three years the transformation in geologic work has been in progress and is now practically accomplished. Thirteen atlas folios are now engraved, and the field-work for about 160 atlas folios is completed, while the field-work required for a still larger number is in progress. In addition to these completed surveys, a general reconnaissance has been extended over about four fifths of the entire area of the United States, and a reconnaissance map representing the results of this work is now in the hands of the engraver.

## THE GEOLOGICAL SOCIETY OF AMERICA.

THE fifth annual and winter meeting of the Geological Society of America was held in Ottawa, Canada, beginning Wednesday, Dec. 28, 1892.

Through the kindness of Dr. J. G. Bourinot, C.M.G. of the Royal Society of Canada and clerk of the House of Commons the ample and commodious room of the Railway Committee of the House of Commons was placed at the disposal of the society. There were about forty Fellows present, sixteen of whom came from various portions of the United States. The meeting was under the presidency of Mr. G. K. Gilbert, Chief Geologist of the United States Geological Survey, Washington, whilst Prof. H. L. Fairchild of the University of Rochester was secretary.

If we are to judge by the attendance and interest manifested at the meeting, as well as by the grade of papers presented, there is no doubt that it was a decided success. A local committee composed of Fellows of the Royal Society, members of the Logan Club, which comprises the scientific staff of the Geological Survey of Canada, etc., had made all necessary arrangements for the comfort and lodging of the members during the meeting. Dr. Selwyn, as chairman of the committee, and Mr. Smith as secretary, spared no pains to give the visiting Fellows of the Society a good reception. Much praise is also due His Excellency the Governor General for the exceedingly kind and generous manner in which he devoted so much time and attention to the society besides furnishing the Fellows from a distance with an excellent opportunity of having a glimpse of social life at the Canadian capital by giving an "at home" at Rideau on Friday afternoon. To Dr. Ells, Mr. J. B. Tyrrell and others, much credit is due for their exertions in preparing matters.

Shortly after ten o'clock on Wednesday, the 28th, President Gilbert took the chair and called upon His Excellency the Governor General to give the address of welcome. His Excellency made a very neat address which was received enthusiastically. To this the president replied, and referred to the proverbial hospitality for which Canadians were noted. The report of the Council was then presented by the secretary and the result of the vote announced so far as conclusions were arrived at. The following leading officers were then declared elected: President, Sir J. William Dawson; secretary, Prof. H. L. Fairchild; treasurer, Dr. T. C. White. The Secretary's report, as well as that of the treasurer, showed the society to be in a flourishing condition. Then followed obituary notices of three deceased Fellows: T. Sterry Hunt, J. S. Newberry, and J. H. Chapin. Prof. Raphael Pumpelly's notice of Dr. Hunt was read by Mr. Van Hise; that of Prof. Newberry, prepared by Dr. Kemp, was read by Prof. H. L. Fairchild; and Prof. Hitchcock read W. M. Davis's memorial of J. H. Chapin.

The reading of papers or work proper of the society began Wednesday afternoon at 2 P.M. Below is a list of the papers, in the order in which they were taken up at the meetings. The whole time of the society was taken up reading and discussing papers until a late hour Friday, the 30th of December. Time and space do not allow us here to do justice to the interesting discussions on the papers presented. Both Glacial and Archæan geology received a goodly share of animated discussion, whilst a few papers on palæontology also stimulated further inquiry. Dr. Willard Hayes's paper on "The new geology" was a splendid contribution to the geomorphology of the district examined by that author and described by him.

**List of Papers.**

A. R. C. Selwyn, On the coals and petroleum of the Crow's Nest Pass, Rocky Mountains; H. P. Brumell, On the geology of natural gas and petroleum in Ontario; H. P. Brumell, Note on the occurrence of petroleum in Gaspé, Quebec; Elfric Drew Ingall, Some features of the phosphate-bearing rocks of Ottawa (read by title); Sir J. William Dawson, Note on sponges found in the Cambro-Silurian at Little Metis, Canada (read in the absence of the author by Mr. F. D. Adams); J. F. Whiteaves, Notes on the Devonian formation of Manitoba and the N. W. Territories; Henry M. Ami, Notes on Cambrian fossils from the Selkirks and Rocky Mountain Region of Canada; Henry M. Ami, On the Potsdam and Calciferous terranes of the Ottawa Palæozoic basin; R. D. Salisbury, Distinct glacial epochs, and the criteria for their recognition; J. B. Tyrrell, Pleistocene phenomena in the region southeast and east of Lake Athabasca, Canada; A. P. Low, Notes on the glacial geology of the Northeast Territories; Robert Chalmers, The height of the Bay of Fundy coast in the glacial period relative to sea-level, as evidenced by marine fossils in the boulder clay at Saint John, New Brunswick; W. J. McGee, The Pleistocene history of Northeastern Iowa; Warren Upham, Eskers near Rochester, N. Y.; Warren Upham, Comparison of Pleistocene and present ice-sheets; G. Frederick Wright, The post-glacial outlet of the Great Lakes through Lake Nipissing and the Mattawa River; N. H. Darton, On certain features in the distribution of the Columbia formation on the Middle Atlantic slope; George M. Dawson, Note on the geology of Middleton Island, Alaska (read by R. W. Ells); Waldemar Lindgren, Two Neocene Rivers of California; Robert W. Ells, On the Laurentian of the Ottawa district; Robert Bell, The contact of the Laurentian and Huronion north of Lake Huron; W. H. C. Smith, The Archæan Rocks west of Lake Superior; Alfred E. Barlow, On the Archæan of Sudbury mining district; C. R. Van Hise, The volcanics of the Huronian south of Lake Superior; Charles Rollin Keyes, Some Maryland granites and their origin (read by Mr. U. S. Grant); Charles Rollin Keyes, Epidote as a primary component in granites (read by Mr. U. S. Grant); James McEvoy, Notes on the gold range in British Columbia; Israel C. Russell, A geological reconnoissance in the central part of the State of Washington; R. W. Ells, The importance of photography in illustrating geological structure; J. W. Powell, The work of the United States Geological Survey (read by W. J. McGee); J. S. Diller, Cretaceous and Tertiary rocks of the Pacific States; T. W. Stanton, On the faunas of the Shasta and Chico formations; C. Willard Hayes and M. R. Campbell, Geomorphology of the southern Appalachians; N. H. Darton, Overthrust faults in eastern New York (read by W. J. McGee).

The president's address, on the "Problems of the Continents," was an admirable paper which brings up and introduces a subject of paramount importance. It serves as a preliminary basis for work at the coming meeting of geologists at the International Congress to be held in Chicago this summer.

Mr. W. J. McGee's public lecture was given in the new auditorium of the Normal School, on the subject "A fossil earthquake;" seldom has an Ottawa audience listened to a clearer and more striking bit of inductive reasoning than this lecture. About 300 persons were present, and the lecture was illustrated by stereopticon views. Mr. H. N. Topley kindly assisted the lecturer in this matter.

After the reading of the last papers on the list and programme on Friday evening, three votes of thanks were unanimously passed by the society. The first to the President and Fellows of the Royal Society, for their invitation and attention during the session of the Geological Society. The second to the Governor General for his hospitality and the generous as well as gracious interest he had taken in the meetings. The third to the Logan Club of Ottawa for its exertions in making the meeting a success.

One interesting feature of these meetings was the presence of the Premier of Canada, the Hon. Sir John Thompson, K.C.M.G., and of the Hon. T. M. Daly, Minister of the Interior and Geological Survey Department, when Dr. McGee read the paper prepared by Major J. W. Powell, director of the United States Geological Survey on the work of that survey. At the conclusion of the paper Sir John Thompson, Mr. Daly, M P., and Dr. Selwyn took part in the discussion. The comparative work and usefulness of the Geological Surveys of Canada and the United States was an interesting as well as practical question.

Altogether the meetings were most successful and teeming with interest, and closed with hopes of having another similar one at no distant date.

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## SEVENTH ANNUAL MEETING OF THE IOWA ACADEMY OF SCIENCE.

The seventh annual meeting of the Iowa Academy of Science convened in the High School Building in Cedar Rapids. Several enthusiastic sessions were held during day and evening of the 27th and 28th. The following papers were read: —

Professor S. Calvin presented a paper "On the Relation of the Woodbury Sandstones and Shales and the Inoceramus Beds of White to the Subdivisions of the Cretaceous proposed by Meek and Hayden," in which he gave a thorough review of the subject and illustrations of various sections bearing upon it. Perhaps one of the most important points of the paper was in regard to the identity of strata differing lithologically at different points, but proven to be the same, and in the view of the author the difference due simply to difference in distance from the shore line of the water in which they were deposited.

In a paper on "The Structure and Probable Affinities of Cerionites dactyloides Owen," Professor Calvin discussed the former views regarding this problematic fossil and showed some very fine specimens and drawings illustrating his view that this is a gigantic Prototozoan or colony of protozoans, a view which, with the evidence presented, seems more reasonable than any hitherto offered.

Dr. C. R. Keyes read a paper "On Natural Gas and Oil in Iowa," in which he maintained that the failure to find these materials in paying quantities so far in this State is not to be taken as proof that they will not be found. He also presented by title two papers, one entitled "Some Mineralogical Notes," and the other "Surface Disintegration of Granitic Masses and Some American Eruptive Granites."

Professor J. L. Tilton, in a paper "From Ford to Winterset," gave a number of carefully determined sections of the various exposures between these towns, and illustrated by a large chart in which they were shown drawn to scale for the entire distance.

Professor C. O. Bates discussed the "Analysis of Water for Railway Engines," giving details of his work in this line and suggestions as to the methods to be used and the results desired in such work.

Professor F. M. Witter, in "Some Observations on Helix cooperi," gave an interesting account of his observations on this mollusk in Colorado and exhibited a number of specimens of different ages.

His paper on the "Absence of Ferns between Fort Collins and Meeker, Colorado," contained a statement of his efforts to secure these plants in that region and discussed the causes for paucity of such material.

Professor Witter also presented a paper entitled "Notice of Stone Implements from Mercer County, Illinois, and Louisa County, Iowa," and accompanied it with exhibition of two very interesting stone implements.

Mr. Gilman Drew discussed "The Frogs' Lease of Life," giving a graphic account of the ability of frogs to survive under adverse circumstances, and showing that it has a very strong vitality. Details of a number of experiments in subjecting frogs to temperatures at varying points below freezing were given, also observations on the vitality of frogs' eggs.

Mr. Drew also remarked upon the inheritance of acquired characters as illustrated in the Honey Bee.

Professor C. C. Nutting, the retiring president of the Academy, took as his subject for presidential address "What We Have Been Doing," and showed in a very exhaustive and pleasing article what the members of the Academy had been engaged in scientifically during the year past. His paper will be an interesting bibliography of the scientific papers published by Iowa men.

Professor Nutting's "Report as Chairman of the Committee on State Fauna" contained a number of additions to the known fauna of the State and notes on varied faunal relations among a number of species heretofore recognized. The additions, which embrace only Vertebrates, include two mammals, nineteen birds, five reptiles, one batrachian, and five fishes.

The "Significance of the Concealed Crests of the Tyrannidae" was the title of another paper by the same author and discussed very elaborately the origin and use of the bright colored crests of different members of the Flycatcher family. Considerable evidence was produced to show that they assist the birds in securing food by alluring insects within easy reach.

Professor L. H. Pammel presented papers on "Phænological Notes for 1892," "Relation of Frost to Certain Plants," "Notes on the Flora of Arkansas and Texas," and "Pollination of Cucurbits."

The second paper contained records of numerous observations on temperatures and effect on different kinds of vegetation. The third contained notes collected by the author during two trips in the region mentioned, and the third, which was accompanied by a number of very fine drawings illustrating the anatomy of the flowers of cucurbits, a number of observations with regard to the pollination of these plants.

Mr. F. C. Stewart presented a paper on "Palisade Cells and Stomata of Leaves," giving record of numerous examinations of leaves of various plants, and especially of different varieties of apple and presenting the conclusion that these factors have little relation to the resistance of the plants to climatic conditions. Mr. Stewart also presented a "Key to the Identification of Weed Seeds."

Mr. H. A. Gossard presented "A List of Insects that have been taken in Clover, in Iowa," with observations on a number of the different species. It includes a large proportion of the species that have been accredited to this plant heretofore and a number of species not hitherto accredited with feeding upon it.

Dr. W. B. Niles presented "Preliminary Observations on a Cattle Disease of Frequent Occurrence in Some Parts of Iowa." In this paper the symptoms of the disease were described, and a statement of efforts to secure cultures of organisms occurring in the diseased animals. Inoculations direct from diseased animals had produced similar symptoms and disease, but inoculations with pure cultures of any of the organisms isolated had so far given negative results.

Mr. F. Reppert presented some "Notes on the Flora of Muscatine," containing record of some plants which appear to be quite out of their normal range. He described the peculiar conditions of the locality where most of these exceptional plants have occurred and suggested that such plants had probably been introduced there by the agency of such birds as ducks or geese.

Mr. F. W. Mally presented a "List of the Tenthredinidæ of Iowa," preliminary to a more exhaustive study of this group in the State.

Professor Herbert Osborn and F. A. Sirrine in "Notes on Aphididæ" presented a list of about forty species that had not hitherto been recognized in the State and notes of the habits of a number of species, also a description of a new species.

Professor Osborn also read a paper "On the Life Histories of Certain Jassidae," giving in detail the life histories of *Deltocephalus inimicus*, *Deltocephalus debilis*, and some others, and mentioned their relation to economic treatment of these species.

He also presented some notes on the "Catalogue of Iowa Hemiptera," making some additions and corrections to preceding lists.

His talk on a collecting trip to southern Mexico contained observations on various points visited as far south as Isthmus of Tehuantepec and references to the native people and animals observed. The talk was illustrated with lantern views of scenery in the localities visited and views showing costumes of the natives, animals of the region, etc.

The Proceedings of the Academy are now published by the State, a bill for that purpose having passed the last Legislature, and the papers presented at this meeting will be printed as soon as possible.

The officers for the current year are: President, L. H. Pammel, Ames; first vice-president, C. O. Bates, Cedar Rapids; second vice-president, A. A. Veblen, Iowa City; secretary-treasurer, Herbert Osborn, Ames; Executive Committee, the officers and S. Calvin, Iowa City; F. M. Witter, Muscatine, and H. W. Norris, Grinnell.

## UNUSUAL ABUNDANCE OF THE GROSBEAK IN EASTERN MASSACHUSETTS.

BY J. H. BOWLES, PONKAPOAG, MASS.

ALTHOUGH considerable of a rambler, I have never until this year noticed the Pine Grosbeak (*Pinicola canadensis*) in this vicinity. The unusually cold weather that we have had this winter seems to have thoroughly disturbed them in their northern homes, as, for the last two weeks, they have been around here in great numbers. The first that I noticed was a flock of six, on Dec. 19, which were feeding on cone-seeds in the top of a hemlock tree. Since then I have noticed flocks, almost every day, ranging in numbers from three to seventeen, although small flocks of six or eight are most commonly seen. Only a very few were in the full red plumage, most of them showing it on the head and rump only. Their flight is exceedingly graceful, consisting of dips toward the ground, in the manner of a woodpecker, only not so much exaggerated, in which they utter from time to time a short, mellow whistle. They are seen principally feeding on the buds of maple, walnut, ash, and evergreen trees, and seem to be always hungry, which, I think, in a measure accounts for their extreme tameness, as they will allow a person to approach within a few feet of them without taking any notice. When feeding in the road, which they sometimes do, they will allow a team to come almost on top of them before flying to the side of the road, only to come back again as soon as the team has passed. I cannot help mentioning here that the trait of coming one winter and being absent the next is very common with some birds. The Snow Bunting (*Plectrophanes nivalis*), for instance, although seen in large numbers last winter, has not made its appearance once this year as far as I have heard. Certainly it is not so plentiful, as last winter I saw a large number of flocks of from six to fifty and one flock of about one hundred and fifty. The red-bellied Nuthatch (*Sitta Canadensis*) and the Yellow Red-Poll Warbler (*Dendroica palmarum*) also, which were very common several winters ago, have been completely missing since that time.

## NOTES AND NEWS.

FOUR courses of lectures are being given by the Department of Biology of Columbia College, in Room 11, Library Building, on successive Thursday evenings, at eight o'clock, beginning Nov. 10, 1892. They are designed for those who desire to keep abreast of the later advances in biology without entering any of the technical courses. A limited number of tickets for the entire course will be issued to persons not students on payment of a small fee. Application should be made to the Secretary of the President, Columbia College. The course on the History of the Theory of Evolution, by Henry F. Osborn, Sc.D., Da Costa professor of biology, was finished Dec. 15. A course on The Cellular Basis of Heredity and Development, by Edmund B. Wilson, Ph.D., adjunct professor of biology, beginning Thursday, Jan. 12, will consist of: Introduction: Cellular Basis of the Living Body. The Germ-Cells: Sex and Fertilization. Cell Genesis and Division. Egg and Spermatozoön: The Preparation for Development. Physiology of the Individual Cell. Inter-Cellular Dynamics: Theories of Heredity. This course will be of the greatest interest, as the progress during the last two years in our knowledge of the cell is simply marvellous. Courses will follow on The Origin and Evolution of the Fishes, by Bashford Dean, Ph.D., instructor in Biology, and Amphioxus and Other Ancestors of the Vertebrates, by Arthur Willey, B.Sc., tutor in Biology.

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Attention is called to the "Wants" column. It is invaluable to those who use it in soliciting information or seeking new positions. The name and address of applicants should be given in full, so that answers will go direct to them. The "Exchange" column is likewise open.

## RECENT PROGRESS IN AMERICAN HORTICULTURE.[1]

BY L. H. BAILEY, ITHACA, N.Y.

You have asked me to say something about recent progress in horticulture. I am at a loss to know how you want the subject treated. The subject is a large one, and can be approached in many ways. It is by no means admitted that there is any recent progress. There is a large class of our horticultural public which disparages these modern times as in no way so good as those of several or many years ago. These men are mostly gardeners who were apprenticed in their youth. There is another class which decries the introduction of new varieties of plants, thinking these novelties to be unreliable and deceitful. There are others who are content with the older things and who have never had occasion to ask if there has been any progress in recent years. Others have looked for progress, but have not found it. A professor of horticulture told me a few days ago that nothing new nor interesting seems to be transpiring in the horticultural world. Some people even deny outright that any progress is making at the present time. On the other hand, there are some, perhaps the minority, who contend that they see great advancement. Perhaps these are mostly young men. Then there are the catalogues with their fascinating impossibilities, pregnant with the glory that is to come. Between all these diversities, where is the young man to stand who loves plants and sunshine and is yet ambitious? Is there any progress in horticulture? If not, it is dead, uninspiring. We cannot live on the past, good as it is; we must draw our inspiration from the future. This subject is of vital personal interest to me; it must be so to you.

I cannot forego the satisfaction of saying at the outset, that some of this supposed stagnation must be due to blindness on the part of the observer. The apprenticed gardener underwent in his youth the stupendous misfortune of having learned the art and science of horticulture. The apprentice system, in itself, does not often educate a man; that is, it does not make him a student. It teaches him to base the whole art upon rule, personal experience and "authority;" it is apt to make him a narrow man, and he may not readily assimilate novel methods. Those who have looked for progress and have not found it, may have looked in the wrong place. It is possible that they do not understand very clearly just what progress is. Those who are simply indifferent exert little influence upon our inquiry and may be omitted. Those who see progress upon all sides may be over-sanguine. Perhaps they project something of their own passion into their statements. And the catalogues, being for the most part editorial rather than horticultural productions, may be liberally discounted as evidence. It is apparent, therefore, that we must make an independent inquiry if we are to answer our own question. Several considerations incline me to believe that progress is not only making, but that it is making very rapidly. And I may say here that I care little for any facts or illustrations of progress merely as facts. There must be some law, some tendency, some profound movement underlying it all, and this we must discover. I shall not attempt, therefore, to indicate how great the progress has been in any definite time, but endeavor to ascertain if there is progression which gains impetus with the years.

1. *There is a progressive variation in plants.* Horticulture is the science of cultivation of plants. The plant is the beginning and the end. For the plant we till the soil, build green-houses, and transact the business of the garden. All progress, therefore, rests upon the possibility of securing better varieties, those possessing greater intrinsic merit in themselves or better adaptations to certain purposes or regions. In other words, all progress rests upon the fact that evolution is still operative, that garden plants, like wild animals and plants, are more or less constantly undergoing modification. American horticulture may be said to have begun with the opening of the century. It was in 1806 that Bernard M'Mahon wrote his "American Gardener's Calendar." This work contains a catalogue of 3,700 "species and varieties of the most valuable and curious plants hitherto discovered." Among the cultivated varieties of fruits and vegetables, the present reader will see few familiar names. He will observe among the fruits, however, some American types, showing that even at that date American pomology had begun to diverge from the English and French which gave it birth. This is especially true of the apples, for of the fifty-nine kinds in the catalogue about 66 per cent are of American origin. Several nurseries were established in the next thirty years and fresh importations of European varieties were made, so that when Downing, in 1845, described the 190 apples known to be growing in this country, American varieties had fallen to 52 per cent. In 1872, however, when almost 2,000 varieties were described in Downing's second revision, the American kinds had risen to 65 or more per cent, or to about the proportion which they occupied at the opening of the century. At the present time, the per cent of varieties of American origin is much higher, and if we omit from our calculations the obsolete varieties, we find that over 80 per cent of the apples actually cultivated in the older apple regions at the present time are of American origin. The percentage of native varieties, in other words, has risen from nothing to 80 per cent since the apple settlement of the country, and at least once during this time the native productions have recovered from an overwhelming onslaught of foreigners. Except in the cold north and north-west where the apple industry is now experiencing an immigration not unlike that which befell the older States early in the century, few people would think of importing varieties of apples with the expectation that they would prove to be a commercial success in America. Other plants have shown most astounding development. In 1889, 39 varieties of chrysanthemums were introduced in North America; in 1890, 57 varieties; and in 1891, 121 varieties. The chrysanthemum is now the princess of flowers, yet in 1806 M'Mahon barely mentioned it, and there were no named varieties. All this is evidence of the greatest and most substantial progress, and much of it is recent; and there is every reason to believe that this rapid adaptation of plants to new conditions is still in progress in all cultivated species. In fact, the initial and conspicuous stage of such adaptation is just now taking place in the Russian apples in America, in which the American seedlings are even now gaining a greater prominence than some of their parents. Both the parent stock and the seedling brood are radical and progressive departures of recent date. The same modification to suit American environments is seen in every plant which has been cultivated here for a score or more of years. The mulberries are striking examples, for our fruit-bearing varieties are not only different from those of Europe, whence they came, but many of them belong to a species which in Europe is not esteemed for fruit. The European varieties of almonds are now being superceded in California by native seedlings which are said to be much better adapted to our Pacific climate than their recent progenitors. These facts of rapid adaptation are everywhere so patent upon reflection that I need not consider them further at this time. They

[1] Read before the Agricultural and Experimental Union of Ontario, at the Ontario Agricultural College, Guelph, Dec. 23, 1892.

are indisputable evidence that there is permanent contemporaneous progress, and upon them alone I am willing to rest my whole argument.

There is another feature of this contemporaneous variation which must be considered at this point,— the great increase in numbers of varieties. This increase is in part simply an accumulation of the varieties of many years, so that our manuals are apt to contain descriptions of more varieties than are actually cultivated at the time. But much of this increase is an actual multiplication of varieties. That is, there are more varieties of all plants in cultivation now than at any previous time. M'Mahon mentions six beets as grown at his time; in 1889, there were 42 kinds. Then there were 14 cabbages, now there are over 100. Then there were 16 lettuces against about 120 now. He mentions 59 apples, now there are about 2,500 described in this country. He mentions 40 pears, against 1,000 now. There were something over 450 species of plants native to the United States mentioned by M'Mahon, now there are over 2,000 in cultivation. These figures are average examples of the marvellous increase in varieties during the century. I may be met here with the technical objection that M'Mahon did not make a complete catalogue of the plants of his time. This may be true, but it was meant to be practically complete, and it is much the fullest of any early list. Gardening occupied such a limited area a century ago that it could not have been a burdensome task to collect very nearly all the varieties in existence; and any omissions are undoubtedly much overbalanced by the shortcomings of the contemporaneous figures which I have given you. It is certainly true that during the nineteenth century varieties of all the leading species of cultivated plants have multiplied in this country from 200 per cent to 1,000 per cent. This variation still continues, and the sum of novelties of any year probably exceeds that of the preceding year. Every generation sees, for the most part, a new type of plants.

But I suppose that these statements as to the increase of varieties will be accepted without further proof. The question which you all desire to ask me is whether all this increase represents progress. Many poor varieties have been introduced, beyond a doubt, but I am convinced that the general tendency is decidedly progressive. You may cite me the fact that we have not improved upon the Rhode Island Greening and Fall Pippin apples, the Montmorenci cherry, the Green Gage plum, and other varieties which were in cultivation at the opening of the century, as proof of a contrary conviction; but I shall answer that we now have a score of apples as good as the Greening, although we may have none better. This habit of saying that we have not improved upon certain old plants is really a fallacy, for the reference is always made to quality of fruit alone; and, furthermore, the test of progress is not the supplanting of a good variety, but the origination of varieties which shall meet new demands. The more numerous and diverse the varieties of any plant, the more successful will be its cultivation over a wide area, because the greatest number of different conditions — as soils, climates, and uses — will be satisfactorily met. If we had at present only the apples which were grown in M'Mahon's time, apple culture in the prairie States, in our bleak North-West, and even in some of the apple sections of Ontario, would be impossible. We are constantly extending the borders of the cultivation of all fruits by means of these new varieties. The horticultural settlement of our great West and of the cold North is one of the wonders of the time. We should not ask ourselves of a new variety if it is better in all respects than other varieties, but if it will fill some specific need more satisfactorily. If a variety does better than all other varieties in one locality alone, for one specific purpose, it is not a failure, and it represents progress. Every peculiar or isolated region tends to develop a horticulture of its own, but this is possible only with a corresponding initial variation in plants. No doubt many of our discarded varieties failed to find the place or conditions in which they would have succeeded. We should not look upon adverse reports upon the novelties as necessarily denunciatory; they may only indicate that in some places or for some purposes the variety in question is unsatisfactory. I must also call your attention to the fact that while the areas of cultivation have greatly widened in recent years because of the evolution of adaptive varieties, the economic uses of the plants have increased in like ratio. We now have varieties of fruits which are specifically adapted to the making of dried fruit, to canning, to enduring long journeys, and the like; and flowers which meet specific demands in decoration or other uses. The period of maturation of varieties has extended greatly in both directions, so that fruits and flowers are now in season much longer than formerly. The gist of the whole matter is simply this, that our horticultural limits and products have greatly broadened in very recent times by reason of the great increase in number and diversity of varieties; and this leads us to expect that still other wants will be met in like manner, and that the uttermost habitable parts of the country will develop a special horticulture

2. *There is a constant augmentation in new specific types of plants, both from our native flora and by importation from without.* I suppose that there is no parallel to the marvellous evolution of native fruits in America. Within a century we have procured the grapes, cranberries, the most popular gooseberries, some of the mulberries, the raspberries and blackberries, the pecans and some of the chestnuts, from our wild species. Perhaps the strawberries can be traced to the same source. There are many men still living who remember when there was no commercial cultivation of these fruits. Here is progress enough for one century; yet an overwhelming host of new types is coming upon us. I sometimes think that the improved native plants are coming forward so rapidly that we do not properly appreciate them. Witness the perplexing horde of native plums, the varieties even now reaching nearly 200, which are destined to occupy a much larger area of North America than the European plum now occupies. New species of grapes are now coming into cultivation. The dewberries, juneberry, Crandall currant type, buffalo berry, wild apples, and more than a score of lesser worthies, are now spreading into our gardens. Many of these things will be among the staples a hundred years to come. One hundred and eighty-five species of native plants, some for fruit but mostly for ornament, were introduced into commerce last year; and the number of plants native to North America north of Mexico which have come into cultivation is 2,416. Under the stimulus of new conditions, some of these species will vary into hundreds, perhaps thousands, of new forms, and our horticulture will become the richest in the world. It is a privilege to live when great movements are conceived and new agencies first lend themselves to the dominion of man.

Many species have come to us from many parts of the world throughout the century, but the immigration still continues, and perhaps is greater now than at any previous time. It is well nigh impossible to chronicle the new types of ornamental plants which have come to America during the last two decades. Consider the overwhelming introduction of species of orchids alone. Even the wholly new types of fruits are many. Over twenty-five species of edible plants have come to America comparatively recently from Japan alone, and some of these species are already very important. Two of them, the Japanese persimmons and the Japanese plums, are most signal additions, probably exceeding in value any other introductions of species not heretofore in the country, made during the last quarter-century. During the years 1889, 1890, and 1891, some 380 species of plants not in commercial cultivation here were introduced into North America, partly from abroad and partly from our own flora. In the year 1891 alone 219 distinct species were introduced.

Valuable as these new types are in themselves, all experience teaches that we are to expect better things from their cultivated and variable progeny. We can, therefore, scarcely conceive what riches the future will bring.

3. *There is great progress in methods of caring for plants.* The manner of cultivating and caring for plants has changed much during recent years. It is doubtful if all this change represents actual progress in methods, but it indicates inquiry and growth, and it must eventually bring us to the ideal treatment of plants. Some of the change is simply a see-saw from one method to another, according as our knowledge seems to point more strongly in one direction than another. In one decade we may think lime to be an indispensable fertilizer, and in the next it may be discarded; yet we may eventually find that both positions are un-

tenable. Yet there has been a decided uplift in methods of simple tillage and preparation of land and the science of fertilizing the soil; and, moreover, the application of this knowledge is widespread where it was once local or rare. And the application of machinery and mechanical devices to almost every horticultural labor cannot have escaped the attention of the most careless observer.

Among specific horticultural industries, the recent evolution of the glass-house has been remarkable. In 1806 the green-house was still a place in which to keep plants green, and M'Mahon felt obliged to disapprove of living rooms over it to keep the roof from freezing, because they are "not only an additional and unnecessary expense, but they give the building a heavy appearance." The first American green-house, with a wooden roof and heavy sides, was built in 1764. Glass-houses increased in numbers very slowly until the middle of this century, and they can only now be said to be popular. Twenty years ago a glass-house was a luxury or an enterprise suited only to large concerns, and the management of it was to most intelligent people an impenetrable mystery. At the present time, even the humblest gardener, if he is thrifty, can afford a green-house. In fact, the glass-house is rapidly coming to be an indispensable adjunct to nearly all kinds of progressive gardening. The secret of this increasing popularity of the glass-house is the simplicity of construction of the modern building. Large glass, low, straight roofs, light frames, simple foundations, small wrought-iron pipes, portable automatic heaters — these are the innovations which have given the green-house a greater popularity and practicability in America than anywhere else in the world. Yet many of these features would have been heresies when Leuchars wrote his excellent book in 1850.

The simplification and popularization of the glass-house has simplified the management of plants in them. Even laymen are now taking to green-house plant growing, and many of them achieve most gratifying results. The first days of the commercial forcing of plants are still within the memory of many of this audience; and it is only within the present decade that great attention has been given in this country to the forcing of tomatoes, cucumbers, carnations, and many other plants. The business is yet in its infancy. The green-house has also exerted a marked influence upon the plants which are grown in them. There has now appeared a list of varieties of various plants which are especially adapted to the purposes of forcing; and this phenomenon is probably the most important and cogent known proof of contemporaneous evolution.

If one were asked off-hand what is the most conspicuous recent advancement in horticulture, he would undoubtedly cite the advent of the sprays for destroying insects and fungi. These are not only eminently effective, but they were perfected at a time when dismay had overtaken very many of our horticulturists, and they have inspired new hope everywhere, and have stimulated the planting of fruit and ornamentals. I fancy that the future historian will find that the advent of the spray in the latter part of this century marked an important epoch in agricultural pursuits. Yet this epoch is not disconnected from the era before it. It is but a natural outcome or consequence of the rapid increase of insect and fungous enemies, which increase, in turn, is induced by the many disturbing influences of cultivation itself. When we devise effective means of checking the incursions of our foes, therefore, we are only keeping pace with the initial progress fostered by the origination of new varieties and the quickening commercial life of our time. Yet the era of spraying is none the less a mark of great achievement, and we have not yet seen the good of which it will ultimately prove to be capable. But a greater achievement than this must be made before we shall have reached the ideal and inevitable method of combatting external pests: we must learn to so control natural agencies that one will counteract another. Nature keeps all her forces and agencies in comparative equilibrium by pitting one against another in the remorseless struggle for existence. The introduction of insect parasites and predaceans, entomogenous fungi, colonization of insectivorous birds, and the use of strategy in cultivation and in the selection of immune species and varieties and the planning of rotations and companionships of plants, will eventually be so skilfully managed that most of our enemies will be kept under measurable control. A short rotation is now known to be the best means of combatting wire-worms and several other pests. The first great success in this direction in America is the introduction of the Australian vedalia, or lady-bug, to devour the most pestiferous of the orange-tree scales on the Pacific coast. This experiment is pregnant of greater and more abiding results than all the achievements of the sprays. But in your generation and mine, men must shoulder their squirt-guns as our ancestors shouldered their muskets, and see only the promise of the time when they shall be beaten into pruning-hooks and plough shares and there shall come the place of a silent warfare!

4. *There is great progress in the methods of handling and preserving horticultural products.* I need not tell the older men in this audience that there has been progress in the methods of handling fruits. When they were boys, apples and even peaches were taken to market loose in a wagon-box. We have all seen the development of the special-package industry, beginning first with rough bushel baskets or rude crates, then a better made and smaller package which was to be returned to the consignor, and finally the trim and tasty gift packages of the present day. I am sorry to say that some regions have not yet reached this latter stage of development, but their failure to do so only makes the contrast stronger of those who have reached it. Quick transportation and methods of refrigeration have tied the ends of the earth together. Apples in quantity are carried 14,000 miles from Tasmania to England, and in 1890 they reached the San Francisco markets to compete with the fruits of the Pacific coast. From a small beginning in 1845, the exportation of American apples to England and Scotland began to assume commercial importance from 1875 to 1880, until nearly a million and a half barrels have been exported in a single season. It is said that the first bananas were brought to the United States in 1804, and the first full cargo in 1830. Now from eight to ten million bunches arrive annually. The Canary Islands are now shipping tomatoes to London, and the United States will soon be doing the same. Watermelons will follow. California now unloads her green produce in the same market. Even pears are exported from America to Belgium, disputing the old saw that it is unwise to carry coals to Newcastle. The world is our market. But this result may have been achieved with some detriment to home markets and transportation, which have been in some measure overlooked and neglected; but this evil must correct itself in the long run.

Perhaps we owe to a Frenchman the first distinct exposition, some eighty years ago, of a process of preserving perishable articles in hermetically sealed cans; but the process first gained prominence in the United States, and it became known as canning. In 1825, James Monroe signed patents to Thomas Kensett and Ezra Daggett to cover an improvement in the art of preserving, although Kensett appears to have practised his method somewhat extensively as early as 1819. Isaac Winslow of Maine is supposed to have been the pioneer in canning sweet-corn, in 1842. About 1847 the canning industry began to attract general attention, and in that year the tomato was first canned. The exodus to California in 1849 stimulated the industry by creating a demand for unperishable eatables in compact compass. North America now leads the world in the extent, variety, and excellence of its canned products, and much of the material is the product of orchards and gardens. In 1891, the sweet-corn pack of the United States and Canada was 2,799,453 24-can cases, and the tomato pack was 3,405,365 cases! Over 20,000 canning factories give employment, it is said, to about one million persons during the canning season. The rise of the evaporated fruit industry is not less remarkable in its way than that of the canning industry.

There are other marvels of progress in methods of caring for horticultural products, but these examples sufficiently illustrate my position. I am aware that all these things are features of commerce and manufacture rather than of horticulture, but they are responsible for much of the phenomenal extension of horticultural interests in recent years. They have also exerted a powerful influence upon the plants which we cultivate, and varieties have appeared which are particularly adapted to long carriage

and to canning and evaporating. The vegetable kingdom is everywhere responsive to the needs of man.

5. *There is a corresponding evolution in the horticulturist.* The rapidity with which education and general intelligence have spread in recent years is patent to every one. The rural classes have risen with the rest, but among the agricultural pursuits horticulture has probably shown the greatest advance in this respect. The horticulturist grows a great variety of products, many of which are perishable, and all of which demand expedition, neatness, and care in marketing. And these many and various crops bring in a multitude of perplexities which not only demand a ready knowledge for their control, but which are important educators in themselves. The horticulturist lives nearer the markets and the villages than the general farmer, as a rule, and he is more in touch with the world. Downing rejoiced in 1852 that there were "at least a dozen societies in different parts of the Union devoted to the improvement of gardening, and to the dissemination of information on the subject." Since that time a dozen national horticultural societies of various kinds have come into prosperous existence, and there are over fifty societies representing States, provinces, or important geographical districts, while the number of minor societies runs into the hundreds. Over fifty States, Territories, and Provinces have established agricultural schools and experiment stations, all supported by popular sentiment. The derision of "book farming" is well nigh forgotten. Subjects which a few years ago were thought to be "theoretical" and irrelevant are now matters of common conversation. In short, a new type of man is coming onto the farms. This uplift in the common understanding of the science of cultivation, and of the methods of crossing and of skilful selection, is exerting a powerful accelerating influence upon the variation of cultivated plants. But the most important and abiding evolution is that of the man himself; and I expect that the rising intellectual status will ultimately lead people to the farm rather than away from it. We are just now living in a time of conspicuous artificialism; but the farm must be tilled and it must be inviting. When agriculture cannot pay, something is wrong with the times.

These, then, are the chief lines of progress in horticulture, and they are all still operative and capable of indefinite growth. The achievement of a generation has been phenomenal. The prospect is inspiring to both the cultivator and the student.

## THE IMPORTANCE OF "NEXT-TO-NOTHING" IN CHEMISTRY.

BY W. H. PENDLEBURY, M.A. (OXON), SCIENCE LECTURER OF DOVER COLLEGE, ENGLAND.

In the year 1888 the President of the British Association for the Advancement of Science took for the subject of his inaugural address "The Importance of 'Next-to Nothing.'" As a matter of course, Sir Frederick Bramwell treated his subject with his usual wit and ability, and pointed out the influence of small things on the advancement of his particular branch of science—engineering. It might, however, be well to carry the idea still further and to collect together, as far as is possible in a short paper, the facts that have come to light showing the influence of traces of a foreign substance upon chemical change. Some of the facts are almost paradoxical. Take the case of an ordinary coal fire, which was probably one of the first objects which aroused the interest and curiosity of mankind and awakened the instinct of scientific investigation. It is needless to refer to the erroneous views held on the subject of combustion, but it may just be mentioned that the discovery of oxygen seemed to settle the matter and to establish on a firm basis the whole theory of combustion. In the years 1887 and 1888[1] the experiments of Mr. H B. Baker made it quite clear, however, that the presence of aqueous vapor had a great deal more to do with combustion and hence the burning of an ordinary coal fire than we were aware of. He showed that if oxygen be rendered perfectly dry, by leaving it for some time in contact with phosphorus pentoxide, combustion is rendered impossible in such gas. Carbon, sulphur, or phosphorus may be strongly heated in an atmosphere of perfectly dry oxygen without taking fire, and, in fact, the sulphur and phosphorus may be distilled in it. The presence of a trace of moisture at once brings about the combustion. The writer has seen Mr. Baker distil phosphorus in an atmosphere of oxygen and then, whilst the phosphorus was still melted, admit a bubble of oxygen which has been standing over water and at once the phosphorus burst into flame. Hence it is highly probable that the ordinary phenomena of combustion could not take place in our atmosphere if there was not aqueous vapor also present. This would furnish another reason against the probability of the moon's being inhabited, as owing to the absence of aqueous vapor fire would not be possible there.

The great influence of a trace of moisture in bringing about chemical changes in which of itself it is not directly concerned, if we may so express it, is evident from many other observations. Wanklyn discovered that dry chlorine will not combine with dry metallic sodium, but that a trace of moisture will start the reaction. Dixon found that a mixture of carbon monoxide and dry oxygen will not be exploded by the electric spark, but that the presence of a trace of moisture will bring about a silent combination under the influence of the spark, whilst if the gases are moist, the explosion will take place readily.

Again, it has been recently observed that ethylene and oxygen, when perfectly dry, do not explode when acted upon by the electric spark, but the presence of moisture acts in this case as in the former.

Again, carbon dioxide is not absorbed by dry lime. Sulphuretted hydrogen in the dry condition does not tarnish dry silver. Dry iodine does not decompose dry sulphuretted hydrogen.

We may take another example of the influence of next-to-nothing of an impurity in bringing about a change in which its influence had been till lately little regarded. The experiments of Mr. V. H. Veley[2], of Oxford University Museum, on the action of nitric acid on various metals has conclusively shown that the violent action which nitric acid has upon many metals is due to the presence of a trace of nitrous acid in the nitric. He has kept spheres of copper in the strongest nitric acid (freed from the presence of nitrous acid) for some time without any reaction occurring, but when once a trace of nitrous acid or of any nitrite was added, the copper was at once dissolved. The same kind of result was observed when mercury, silver, or bismuth were exchanged for the copper. It was found that from 1 to 2 parts of nitrous acid in 10,000 of the nitric were sufficient to set up the reaction.

Mr. Cross found that jute fibre, when treated with sulphuric acid, is simply hydrolysed. If, however, ordinary nitric acid, containing a trace of nitrous acid, be allowed to act on the jute, a considerable amount of chemical action takes place, and amongst other substances, like urea, which either prevents the formation of nitrous acid or decomposes it as quickly as it is formed, the action of nitric acid on jute is strictly comparable with that of sulphuric acid, simple hydrolysis taking place.

It is highly probable that many of the changes in organic chemistry, generally ascribed to the action of nitric acid alone, are due to the presence of traces of nitrous acid.

It is well known that pure zinc will not dissolve in pure hydrochloric acid or pure sulphuric acid, but the presence of a trace of a metallic salt sets up the reaction very readily.

If we take another branch of chemistry—metallurgical chemistry—the immense importance of the presence or absence of a trace of a foreign substance in a metal is readily seen, since it produces an immediate effect on the hardness or tenacity of the metal, and so may destroy its usefulness in commerce. Take the case of copper. Professor Roberts-Austen states in his Cantor lectures that a cable made of the pure copper of to-day will carry twice as many messages as a similar cable made of the less pure copper of 35 years ago, when the importance of the purity of copper was not so well understood, and he quotes a saying of Sir Wm. Thomson's that the presence of $\frac{1}{10}$ per cent of bismuth in the copper of a cable would entirely destroy its commercial success by reducing its conductivity. Sir Hussey Vivian has

[1] Proceedings of the Royal Society, vol 45, and Phil. Trans., 1889

[2] Philosophical Transactions, 1891.

stated that $\frac{1}{1000}$ part of antimony will convert the best select copper into the worst conceivable. Another instance occurs in the case of iron. By the addition of $\frac{2}{10}$ per cent of carbon steel is produced of such a kind as would make an excellent bridge, or boiler plate, but if fashioned into a weapon would be absolutely untrustworthy. If, on the other hand, $\frac{8}{10}$ per cent of carbon were introduced, a material is obtained from which a good razor might be made, but it would be useless for a rail or the construction of a bridge. A trace of manganese in steel renders it impossible to make a magnet out of such a specimen. It also prevents the hardening of such steel by rapid cooling after heating to redness.

The metal, however, which shows the most remarkable change in its physical properties when contaminated with next-to-nothing of a foreign substance is gold. The addition of $\frac{2}{10}$ per cent of bismuth would render a specimen of gold useless for coinage purposes, as it would crumble to powder under the pressure of the die. Lead acts in a similar way. One part of lead added to two thousand parts of gold reduces its tenacity from 18 tons per square inch to only 5 tons. A bar of such gold can be readily broken by a tap from a hammer. The color of the gold is changed from yellow to orange brown. Such a remarkable change in the appearance and properties of gold on the addition of small quantities of other substances was known in the seventh century and helped to confirm the belief of the alchemists that they had only to find some substance which would alter the properties and appearance of any given metal so that it would change into and acquire the properties of gold. Hence the search for the philosopher's stone.

This paper might be indefinitely extended, but enough has probably been said to show that even in chemistry the day of small things is not to be despised, and that a thorough investigation of some of the commonest and best-known chemical changes would doubtless bring to light many facts at present overlooked, and would tend to a better understanding of the workings of nature.

## BREAD-FRUIT TREES IN NORTH AMERICA.

BY F. H. KNOWLTON, U. S. NATIONAL MUSEUM, WASHINGTON, D.C.

THE living species of the genus Artocarpus are exclusively Old World, being confined in their distribution to tropical Asia and the Malay Archipelago. About forty species have been described, of which number two or three are now widely cultivated throughout the tropics, the most important of these being *A. incisa*, the true bread-fruit tree. They are small or medium-sized trees with a milky juice, and large, leathery, entire, or pinnately lobed, or rarely pinnately compound leaves. The flowers are monœcious with the staminate ones borne in long club-shaped spikes, and the pistillate in rounded heads. The female flowers soon grow together and form one large, fleshy mass, or the so-called bread-fruit. When mature, the fruit is marked on the exterior with hexagonal knobs, and in the interior consists of a whitish pulp, having the consistence of new bread, whence its name.

Although not at present an element in the flora of the New World, there is now abundant evidence to show that the genus Artocarpus was, during late Cretaceous and earlier Tertiary times, an inhabitant of North America. The best known species, called *Artocarpus lessigiana* (Lx.), was discovered in 1874 in the Lower Laramie on Coal Creek, in Boulder County, Colorado. It was first described by the late Professor Leo Lesquereux, under the name of *Myrica ? lessigiana*, on the supposition that it was a gigantic representative of the genus Myrica. Specimens, now known to represent the upper portions of large leaves, were later obtained from the andisitic deposits forming the recently differentiated Denver formation of South Table Mountain, near Golden, Colorado. These leaves were called *Aralia pungens* by Professor Lesquereux, who naturally confounded the imperfect examples at his disposal with well-known fossil forms of this genus, which they much resemble. Since that time several additional specimens have been obtained, which not only prove that *Myrica ? lessigiana* and *Aralia pungens* are identical, but also that they should be referred to Artocarpus.

The leaves of *Artocarpus lessigiana* were very large, measuring 30 centimeters in length and 18 or 20 centimeters in width. They are thick, probably coriacious in texture, broadly oblong in general outline, and deeply, pinnately 4–6-lobed. The lobes are oblong, lanceolate, taper-pointed, and separated at the base by broad, rounded sinuses, the lobation being most extensive at the base of the leaf, where the sinus almost reaches the midrib, and the two lower lobes are connected by a narrow ring only. The nervation of the leaf is very strong, and precisely like that of the living *A. incisa*, which differs from the fossil in having the deepest lobation in the upper part of the leaf.

Closely allied to this species, and possibly identical with it, is what I propose to call *Artocarpus californica*, which is founded upon specimens obtained by Dr. Cooper Curtice, then of the U. S. Geological Survey, from the auriferous gravels at Independence Hill, Placer County, California. This species differs from the former by its smaller size, thinner texture, and shorter, more acute, lobes. It is not sufficiently well preserved to show the finer nervation, but, as far as can be made out, it is very similar to *A. lessigiana*, and additional material may show them to be the same.

Specimens, probably belonging to this species (*A. californica*), were obtained some years ago from the John Day Valley in Oregon, the age of which is either Upper Miocene or Lower Pliocene. They were identified by Professor Lesquereux both with his *Myrica ? lessigiana* and *Aralia pungens*; but, as they are somewhat fragmentary, it is not possible to be positive as to their correct determination.

The most northern point at which the genus Artocarpus has been found fossil is northern Greenland, in latitude 70°. Dr. A. S. Nathorst obtained a large leaf, which he named *A. dicksoni*, in the Cenomanian near Waigatt. This species is also closely related to *A. incisa*, and was associated with a fruit which is unquestionably that of a bread-fruit tree. Nathorst, who was the first to point out the true relationship of Lesquereux's *Myrica ? lessigiana* and *Aralia pungens*, suggests the possibility of their being the descendants of the Greenland species, which may have deen dispersed over the North American continent by the ice-sheet. The material at present available is hardly sufficient to establish unquestioned relationship between them, for the nervation of *A. dicksoni* is not to be made out, but, as all are undoubtedly related to the living bread-fruit (*A. incisa*), they may be more closely related among themselves than now seems apparent.

From the above account, it appears that the bread-fruit trees existed in North America as far north (in Oregon) as 46°, and as late as early Pliocene or late Miocene time. The reason for their complete disappearance from the American flora, and that within such a comparatively short space of time, is difficult to supply. If they had been pushed southward, and now inhabited the tropics, it would be readily explainable, and quite in accord with other well-known instances, but they have totally disappeared from the New World, notwithstanding the fact that they grow when transplanted as freely in tropical America as in their native country. It is probable that the advance of the refrigeration was so rapid that they were unable to escape in the New World, and perished to the last one, while in the Old World some avenue permitted their perpetuation. The genus Eucalyptus is another example of the same condition. During Cretaceous and Tertiary times it was an inhabitant of North America and Greenland, but is now entirely confined to Australia.

The deductions to be drawn, as to the climate that prevailed at the time when these trees existed in North America, are to be made with caution. The fact that all the living species of a genus are tropical does not necessarily prove that it has always been so. Again, a genus that is essentially tropical may have species extending into sub-tropical or even temperate regions. The genus Dicksonia is a marked example of this kind. It is principally an inhabitant of tropical America and Polynesia, but one species reaches as far north as Canada, and several are scattered throughout the southern part of the temperate zone.

Taken by itself, Artocarpus would indicate a tropical climate, but the plants with which it is associated have also great weight

in confirming or modifying this view. In Greenland it is associated with ferns of the order Gleicheniales and at least four species of Cycas, all of which goes to prove that the climate at the time they grew was probably tropical, or at least very warm. In North America the Laramie bread-fruit tree was associated with an abundance of palms, which also argue a warm climate, but in the same beds are found a host of genera (Salix, Populus, Quercus, Juglans, Carga, Magnolia, Ginkgo, Taxodium, Sequoia, etc.), which point with stronger force to a probably temperate climate. The Pacific coast species was found with genera usually relied upon to prove a temperate climate, and while it was undoubtedly warmer than now, for the present forest vegetation is mainly or largely coniferous, there is little beside this to show that it was actually tropical.

## NOTES ON MARS AND METEORS.

BY E. MILLER, LAWRENCE, KANSAS.

THE recent opposition of Mars, the appearance of Holmes's comet, and the meteoric display of the night of Nov. 23, 1892, were events that concentrated the attention not only of the general scientific world, but of specialists also, more largely than such events ever did before. It was thought that some of the celestial riddles were about to be solved, that some positive addition, neither nebulous nor fragmentary in its character, was to be made. Now, that they have all become things of the past, and it becomes possible to sum up the results of all the labor performed, theories propounded and exploded, and computations made, it is no wonder that the "οἱ πολλοι" ever impatient to see tangible results, and always clamorous in demanding large returns for even the smallest expenditures of time, labor, and money, are shouting "imposture." But science is not to be balked in this way; there is no release from this war.

The position of Mars relatively to the earth was such during the recent opposition that the best instruments and the best observers were at a great disadvantage. The results were not altogether satisfactory and in many cases were at variance with old theories and with each other. The observations made in this country, east of the Rocky Mountains, were scarcely of any value at all in the most of them, owing to the hazy condition of the atmosphere, as well as the low altitude of Mars. But west of the Rocky Mountains, especially along the Pacific coast, notably at Lick Observatory and the mountain observatory, near Arequipa, Peru, the conditions were the best attainable. At Guaymas, Mexico, on the coast of the Gulf of California, in latitude 27° 30' N., the writer, about the middle of August, 1892, was impressed with the splendid appearance of Mars. The planet shone with a brilliancy that was almost, if not altogether, as great as it was at the opposition of 1877. Venus and Jupiter, also, seemed to have received extra touches of brilliancy that generally are not so pronounced in latitude 39° N.

Guaymas, located as it is on the shore of the Gulf of California, and surrounded by mountains ranging from a thousand to two thousand feet in height, with a sky that is always of the deepest blue, possesses advantages of a very superior kind, for an astronomical observatory. The great objection to such a location, to a northerner, would be the intense heat of the summer. In addition to the advantages for astronomical work, the harbor of Guaymas, as well as the Gulf itself, offers facilities and material for the study of marine life, that are beyond a doubt unsurpassed. A well-equipped biological station and some good biologists would soon furnish to the scientific world splendid results.

At midnight of August 18, 1892, as the writer was entering the open court of a large adobe house in Guaymas, in company with two or three friends, one of the most beautiful of celestial sights greeted their astonished vision. Suddenly from blue concave of the heavens, about midway between the zenith and the pole star, a meteor of the largest size shot out with a splendor of color such as is not often seen. The orange, red, violet, and other colors, were deep and most handsome to behold. Apparently, the meteor seemed to be moving from its initial point in a southerly direction, and had a disc, so to speak, almost equal to that of the full moon, and a train following that was remarkable for its width as well as its length. The train was broken into blocks of color that made this celestial visitant in all its outline, size, color, and general appearance, an intensely interesting object.

The stream of meteors, called the Andromedes, which our planet encountered on the 23d of November, made a very good display here in Kansas. Although no attempt was made to count the number or estimate the total fall of meteors during the night, except at intervals of five or ten minutes, yet judging from what was done in this discontinuous manner, there must have been an average of from sixty to one hundred meteors per minute from 9 to 11 P.M. The "radiant point" was in Andromeda, from which by far the greater number seemed to start. Many others, apparently, had no connection with the "radiant," for they shot out from other points of the sky and at every moment. Generally, the meteors were small, but at times one more brilliant than the others appeared, adding very much to the interest of the observer. During the next four nights following the night of the 23d, it was hoped that a finer display would make its appearance, but two of the nights were overcast with clouds, and the other two, although clear, offered no show.

## LETTERS TO THE EDITOR.

**** Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

*On request in advance, one hundred copies of the number containing his communication will be furnished free to any correspondent.*

*The editor will be glad to publish any queries consonant with the character of the journal.*

### Breathing Wells.

REFERRING to the article of Mr. J. T. Willard in *Science* for Dec. 16, with reference to a "breathing well" in Kansas, I would say that such wells are also common in Nebraska. I have compared their behavior with the fluctuations of the barometer, and my observations agree with those of the writer in showing the entire dependence of the air movements in the well upon the changes in the atmospheric pressure outside. The cessation of an outward current from the well always corresponds with a curve of barometric depression, but always occurs some hours later than the minimum of pressure, and the amount of retardation depends upon the slowness with which the barometer rises.

These wells have often given considerable trouble in cold weather as the influx of cold air is liable to freeze the water in the pump at a considerable depth below the surface of the ground.

GOODWIN D. SWEZEY.

Crete, Neb., Dec. 23.

### Hybridism in Genus Colaptes.

ACCORDING to the *résumé* of hybridism in the genus Colaptes by Professor Rhoads in *Science* for Dec. 9, it would appear that King's River was out of the limit of variation. Still I found one adult male of *C. cafer* at Dunlap, Cal., in the Sierra Nevadas, about 3,500 feet elevation, a perfect representative in every way save the occipital mark of *C. auratus*.

I also found an adult male in Cantua Creek, in the coast range, with the same marking. The former was in January, 1891, the latter in April, 1892. As both of these were found dead, I thought possibly the marking might have been caused by old age; but more probably they were stragglers from the north.

ALVAH A. EATON.

Riverdale, Cal., Dec. 26.

### How Shall I Study Ants?

CAN some naturalist refer me to some article or book, or tell me himself how I can best keep a colony of ants, for inspection.

DWIGHT GODDARD.

Hosmer Hall, Hartford, Conn., Jan. 6.

## BOOK-REVIEWS.

*Waterdale Researches;* or, Fresh Light on Dynamic Action. By "WATERDALE." London, Chapman & Hall, 1892. 12mo. pp. vi., 293.

*Cosmical Evolution:* A New Theory of the Mechanism of Nature. By E. McLENNAN. Chicago, Donahue, Hennenberry, & Co., 1890. 12mo. 399 p. $2.

IN these volumes we have interesting illustrations of those methods of thought, and their results, which are characteristic of the attempts of amateurs in science to bring contributions of new thought and novel theories to the attention of scientific men. In the first-named, the anonymous author, writing under the *nom de plume* "Waterdale," presents his "discovery of a cause for gravity other than the hypothesis of attraction," and "other theorems as important." That an amateur should, especially in physical science, have the courage to propose to lead the connoisseur in the serious consideration of presumably crude notions—in these days of higher research, when even the professional expert finds himself entirely at a loss to find a way, even in following the specialist in other lines than his own, and entirely unable to propose original theories—speaks well for the confidence, if not for the discretion, of the ingenuous adventurer. We regret to say that we must coincide with the reviewer in *Nature* and the critic in *Science and Art*, who are apparently unable to find anything novel in what is right in the book, or anything right in what is novel. The idea that some other explanation of the action of forces on matter than that provisionally held, that of an inherent attractive "action at a distance," is as old as Greek philosophy, and remains, no doubt, an admitted probability among the best thinkers and most expert physicists and chemists of the time; but our author and Sir Isaac Newton are alike in the dark as to the real nature of the action noted. The proposed substitution of another term for the well-understood and precisely-defined word *mass*, certainly affords no aid to either imagination or experience.

The author introduces his book into the United States "in the hope that there is there less clique-prejudice among scientists than in England;" but we fear that, here as in Europe, the prejudice that the man who has made a life-work of the study of a subject and has acquired reputation through actual investigation and systematic research, through exact and productive measurement, is competent to act as the adviser of the laymen, and that the amateur with an unscientific imagination, unfamiliar even with the precision of scientific definition, can claim little consideration when thus out of his element, will be found unconquerable. This book is written in such vague and ildefined language that its assertion that it presents "substantial evidence that energy pervades the ethereal fluid with which every sphere is surrounded" will hardly be taken as substantiated, however well established the fact may be; and its "law of induction" that "every substance, by exchange during pulsation of fine matter internally from one atom to another, sets up increased hydraulic force with fine matter, which force decreases inversely as the square of the distance through which the force has at any point reached" will hardly displace Newton's laws. Its author is not yet a sufficiently advanced student to be prepared to teach.

Of Mr. McLennan's book, it may at least be said that, although the author is an amateur in that lofty region of scientific philosophy into which he endeavors to find entrance, and has as yet never earned that right of prophecy which only comes to the man who becomes known as thoroughly familiar with existing human knowledge and the grandest of modern achievements, and who himself has done his part in promoting positive learning, he has certainly collated numerous facts of real interest and of possible, if not probable, importance in the relations to which he seeks to attach them. But his supposed original matter seems based upon imagination rather than ascertained fact; and we can find little

### CALENDAR OF SOCIETIES.

**Anthropological Society, Washington.**

Dec. 20.—Symposium, Is Simplified Spelling Feasible? Discussion by F. A. March, A. R. Spofford, Wm. T. Harris, and Edwin Willits.

Dec. 27.—Continuation of Symposium, Is Simplified Spelling Feasible? Discussion by Alexander Melville Bell, E. M. Gallaudet, John M. Gregory, Benj. E. Smith, Charles R. G. Scott, and W. B. Owen.

Jan. 3.—Close of the Symposium, Is Simplified Spelling Feasible as Proposed by the English and American Philological Societies? Discussion by Lester F. Ward, Wm. B. Powell, Benj. E. Smith, Charles R. G. Scott, E. T. Peters, John W. Powell, and Weston Flint. The discussion will be closed by A. R. Spofford and Wm. T. Harris.

**Philosophical Society, Washington.**

Jan. 7.—G. K. Gilbert, Illustrations of the Physical History of the Moon (lantern slides); T. C. Mendenhall, The Use of Planes and Knife-Edges in Pendulums.

**Appalachian Mountain Club, Boston.**

Jan. 11.—Warren Upham, Drumlins Near Boston.

connection between the undeniably interesting facts related and that "material connection" between the bodies of our universe, which he claims to have discovered. Whatever may be the real nature of that connection — and we doubt if our author has hit upon it — these facts will, unquestionably, be found perfectly consistent with it, and a part of it; but a thousand other schemes than this may be produced by the poetic imagination of the amateur in science into which these facts may be also worked, and it remains, most likely, for direct investigation, with all the aid of the most perfect modern apparatus and methods, to finally determine solutions of the still numerous problems of contemporary science. The Greek methods of speculation and non-scientific imagination are not of much promise where a "material connection" between the bodies of the solar and other systems of the universe is the subject-matter of investigation. The machinery of the universe must probably be ultimately revealed by expert and practised mechanicians.

*Dynamics of Rotation.* By A. M. WORTHINGTON. London, Longmans & Co. 1892. 155 p. 12°.

A LITTLE book on a very elementary portion of the science of mechanics, as here treated, but an excellent treatise for beginners. Professor Worthington has made his process of instruction a most practical and sensible one — giving first a statement of the facts and data as developed by experiment and then deducing the laws of mechanics applying to the case and finally applying those laws and the equations expressing them to the solution of problems. Such applications are well illustrated by considerable numbers of well-chosen examples. This method of treatment is certainly well suited to the instruction of young students, and we are not sure that it is not the best for older ones in many cases in which the opposite course of enunciating the law and later illustrating it and deducing constants by experiment. We observe that the new term, "torque," is accepted by the author and that he also adopts the "poundal" and the conventional distinction pound for force and lb. for mass. We are not sure that either is needed or desirable; but fashion and convention have almost as much influence in science as in *modes de Paris.* They have probably come to stay, like the barbarous nomenclature of the electricians; but, in this book, the frequent use of the "engineers, or gravitation" units, as its author calls them, will go far toward relieving the mind of its readers of those misapprehensions and confusions which so constantly arise in the study of the older text-books.

*Mechanical Drawing.* By C. W. MCCORD, A.M., Sc.D. New York, J. Wiley & Sons. 245 p. 4°.

THIS large and handsomely made book contains the line of work proposed for use in the elementary instruction of the technical schools, especially those of engineering. The exercises given are those which have proved successful, during twenty years of work, by its author. They are intended to train eye, hand, and judgment as well. "The artificial and often useless stage machinery of descriptive geometry" is kept out of sight as far as possible, although they are not considered entirely useless, nevertheless. Maxims, bits of condensed wisdom, are sprinkled throughout the work, as "Pencil lightly," "Pencil clearly," "Make haste slowly," and are clearly themselves the result of long experience and a fruitful observation. The methods are excellent, the manner of doing the work no less satisfactory; and the whole constitutes one of those rare treatises on a technical subject which can only be produced by an author who is wise in the principles of his craft and experienced, practically, in their application to the actual, live problems of the profession in which he is an expert. The principles of projection, the laying-out of curves, and the construction of problems in connection with the design and adaptation of gearing to its work, illustrate especially this advantage possessed by the author in the present case. This is an admirable work, and author and publishers are alike entitled to great credit.